Component Analysis

Year: 2023 Semester: Spring Team: 18 Project: RDNT

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Assignment Evaluation:

| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| --- | --- | --- | --- | --- |
| **Assignment-Specific Items** | | | | |
| **Analysis of Component 1** |  | x2 |  |  |
| **Analysis of Component 2** |  | x2 |  |  |
| **Analysis of Component 3** |  | x2 |  |  |
| **Bill of Materials** |  | x6 |  |  |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** |  | x2 |  |  |
| **Formatting and Citations** |  | x1 |  |  |
| **Figures and Graphs** |  | x2 |  |  |
| **Technical Writing Style** |  | x3 |  |  |
| **Total Score** |  | | |  |

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

General Comments:

*Relevant overall comments about the paper will be included here*

IMPORTANT NOTE: This team assignment (Component Analysis) and the Bill of Materials are separate team assignments due in subsequent weeks but will be graded together after both have been submitted. Note the weighting of the Bill of Materials in the rubric above.

1.0 Component Analysis:

The major components of our design include a Microcontroller, an External ADC, an External Microphone, and strips of LEDs. The design can take audio input heard by the Microphone (or an AUX input, depending on the mode chosen; AUX is not discussed in this document due to the trivial nature of choosing an AUX port), which is then sent along as an analog signal. The External ADC processes any analog signal, and converts it to a digital signal sent into the Microcontroller. Our Microcontroller is the heart of our design, being able to interface with the other components and coordinate and control their behavior with one another. The LED strips are used to display the result of the effort of the previous devices, responding to the audio input that is processed by the Microcontroller and translated into patterns displayed by the LEDs.

1.1 Analysis of Microcontrollers:

The most important deciding factor when deciding on a Microcontroller to implement was the inclusion of an onboard Bluetooth module. This allows for a third audio input mode, as well as a much simpler process of connecting to our phone. Low-cost was important as we want the total cost of our device to be as low as possible. Previous experience in using the Microcontroller was also considered, but was not a strong decider. The three main families of microcontroller that we considered were the ESP32, ESP8266, and Arduino.

Given that the main function performed by our Microcontroller was processing and audio signal and computing Fast Fourier Transforms, we required a Microcontroller with enough clock speed and onboard memory to process samples and calculate in as close to real-time as we could. Given these requirements, as well as having included Bluetooth functionality made the ESP32 the best choice.

|  | ESP32 | ESP8266 | Arduino |
| --- | --- | --- | --- |
| Clock Speed | 80MHz - 240Mhz | 52MHz | 16 MHz |
| Wi-Fi/Bluetooth | Yes/Yes | Yes/No | Yes/Yes\* |
| Flash Memory | 4 MB | 4 MB | 32-256 KB |
| SRAM | 520 KB | n/a | 2-8 KB |
| EEPROM | n/a\*\* | 512 Bytes | 1024 Bytes |
| SPI/I2C/I2S/UART | 2/1/2/2 | 4/2/2/2 | 1/1/1/1 |
| Price | $11.00 | $6.00 | $22.00+ |

\* Wi-Fi/Bluetooth available only on the Arduino MKR1000

\*\* Simulated by Flash Memory

1.2 Analysis of OmniDirectional Microphone:

Choosing a good omni-directional microphone has a direct influence on the quality of LED output. The quality of input audio directly affects the accuracy and reactivity of our LED show. There are several areas where this quality could be degraded, like during noise reduction, filtering, and fourier transform. Not only must we focus on minimizing losses, we must start with a microphone that is aligned with the purposes of our application and would be useful in the environmental conditions of our device.

|  | MAX9814 | CMA-4544PF-W | AOM-5035L-HD3-LW100-R |
| --- | --- | --- | --- |
| Signal to Noise Ratio [SNR] A-Weighted (dBA) | 64 | 60 | 75 |
| Current Consumption (mA) | 3.1 | 0.5 | 0.6 |
| Senstivity (dB) | -42 | -44 | -35 |
| Frequency Range [Hz] | 20-20000 | 20-20000 | 20-20000 |
| Maximum Sound Pressure Level [SPL] (dB) | 110 | 94 | 135 |
| Cost ($) | 7.95 | 0.78 | 4.45 |

The MAX9814 has an inbuilt op-amp with automatic gain control, making it a good choice for hobbyists. However, this feature is not a significant factor as we can focus on creating our own op-amp more economically and with a better microphone to produce more useful audio signals.

We will be using the AOM-5035L-HD3-LW100-R for microphone input. It provides a very good audio input at a reasonal price. Moreover, since we are considering applications where both noise and sound level may be high and the SPL is also critical, we need to implement a microphone that has a slightly lower sensitivity and high SPL and SNR values.

<https://www.cuidevices.com/product/resource/cma-4544pf-w.pdf>

<https://api.puiaudio.com/file/6c8b525b-a9f7-4b7d-827f-f816aaf4768a.pdf>

<https://cdn-shop.adafruit.com/datasheets/MAX9814.pdf>

1.3 Analysis of LED Strips:

The LEDs are the final component of our design that ties everything else together, since they are the nexus of all the other components and their operations. The LEDs are meant to synchronize to the beat of certain instruments or sounds by flashing certain patterns and colors, so when considering LED strips, the main requirements were a full range of color and the ability to individually control each LED on the strip, ideally through the microcontroller directly. Other technical specifications, such as electrical requirements or thermal output were factors that we felt were able to be fulfilled once we confirmed the LEDs’ ability to be individually addressed.

We quickly decided on the WS2812B LED strip due to its wide usage and popularity, cost effectiveness, and scalability with multiple strips.

2.0 Sources Cited:

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